INTERNATIONAL STANDARDS FOR PHYTOSANITARY MEASURES

REQUIREMENTS FOR THE ESTABLISHMENT AND MAINTENANCE OF PEST FREE AREAS FOR TEPHRITID FRUIT FLIES

Secretariat of the International Plant Protection Convention
FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
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INTRODUCTION

SCOPE

This standard provides the guidelines to establish, maintain and verify pest free areas for tephritid fruit flies. This standard applies to all fruit flies of economic importance.

REFERENCES

Determination of pest status in an area, 1998. ISPM No. 8, FAO, Rome.
Glossary of phytosanitary terms, 2004. ISPM No. 5, FAO, Rome.
Guidelines for pest eradication programmes, 1998. ISPM No. 9, FAO, Rome.
Guidelines for surveillance, 1997. ISPM No. 6, FAO, Rome.
Pest reporting, 2002. ISPM No. 17, FAO, Rome.
Requirements for the establishment of pest free areas, 1996. ISPM No. 4, FAO, Rome.
Requirements for the establishment of pest free places of production and pest free production sites, 1999. ISPM No. 10, FAO, Rome.

DEFINITIONS[1]

At its Seventh session in April 2005, the Interim Commission on Phytosanitary Measures adopted recommendations on the publication of ISPMs in a book format (see ICPM-7 report, paragraph 39 and Appendix II). Each book of ISPMs will contain a glossary chapter, i.e. the *Glossary of phytosanitary terms* (ISPM No. 5) in the relevant language.

The "definitions" section in the present ISPM, once integrated into the book, will not contain any definitions but will refer to the Glossary chapter of the book (ISPM No. 5). However, for the purpose of country consultation, this section contains terms or definitions which are new or revised in the present draft standard. Once this standard has been adopted, the new and revised terms and definitions will be transferred into the Glossary chapter of the book (ISPM No. 5), and will not appear in the standard itself.

New term and definition:

detection	The discovery of a specimen of the target pest.

OUTLINE OF REQUIREMENTS

The general requirements to be considered in preparing to set up a fruit fly-pest free area (FF-PFA) include: consideration of the possible need for a buffer zone; the preparation of a public awareness programme; and the management elements of the system (documentation and review systems, record keeping and a quality assurance programme).

The major elements of the FF-PFA are: the determination of the FF-PFA; the establishment of the FF-PFA; the verification and declaration of pest freedom; and the maintenance of the FF-PFA. These elements include the surveillance activities of trapping and fruit sampling and regulatory controls on the movement of host material or regulated articles. Detailed guidance on surveillance activities is provided in Annexes 1 and 2.

Additional requirements include: corrective action planning, the suspension, termination and reinstatement (if possible) of the FF-PFA and the establishment of specific trading arrangements if required. Corrective action planning is described in Annex 3.

BACKGROUND

Fruit flies are a very important group of pests for many countries due to their potential to cause damage in fruits and to restrict international market for these products. The high probability of introduction and establishment of these pests associated with a wide range of hosts results in restrictions for many importing countries to accept fruits from areas in which these pests are established. For these reasons, there is a need for an ISPM that provides specific guidance for the establishment and maintenance of pest free areas for fruit flies.

ISPM No. 4 (*Requirements for the establishment of pest free areas*) provides general guidance on the establishment of pest free areas. A need for additional guidance on establishment and maintenance of pest free areas for fruit flies (fruit fly-pest free areas, FF-PFA) was recognized. This specific standard describes the requirements for FF-PFAs. The target pests for this standard include insects of the order Diptera, family Tephritidae, of the genera *Anastrepha, Bactrocera, Ceratitis, Dacus, Rhagoletis* and *Toxotrypana*. See Appendix 1 for the most important fruit fly pests.

The establishment of a FF-PFA and its recognition by trading partners implies that no other phytosanitary measures are required for the target species of fruit fly for host commodities from the PFA.

This standard only refers to pest free areas for fruit flies and does not cover pest free places of production or pest free production sites for fruit flies (see ISPM No. 10: *Requirements for the establishment of pest free places of production and pest free production sites*).

REQUIREMENTS

1. General Requirements

A pest free area is "*an area in which a specific pest does not occur as demonstrated by scientific evidence and in which, where appropriate, this condition is being officially maintained*" (see ISPM No. 5). Areas may be naturally free from fruit flies (though fruit flies have the potential to establish there) or may be made free by an eradication programme (see ISPM No. 9: *Guidelines for pest eradication programmes*). ISPM No. 4 (*Requirements for the establishment of pest free areas*) describes different types of pest free areas. In particular it distinguishes between freedom for an entire country and freedom for part of a country.

In cases where the fruit flies concerned are known to be absent from an area such as an entire country or several countries, general surveillance in accordance with section 3.1.2 of ISPM No. 8 (*Determination of pest status in an area*), where appropriate in combination with the implementation of import requirements against the introduction of the relevant fruit fly species into the area, is normally sufficient to establish and maintain the area pest free.

In cases where the PFA is situated near or within an infested area, official control and specific procedures as further described in this standard are required for its establishment and maintenance. The decision to establish such a FF-PFA is made by the NPPO based on technical and socio-economic feasibility. The technical factors include components such as: pest population levels, isolation, climate, geography and availability of methods for pest eradication.

All the procedures for the establishment, verification of pest freedom and maintenance of such FF-PFA should form part of an official control programme. "*As this type of PFA is likely to involve an agreement between trade partners, its implementation would need to be reviewed and evaluated by the NPPO of the importing country*."(ISPM No. 4: *Requirements for the establishment of pest free areas*).

1.1 Buffer zone

In areas where geographic isolation is not considered adequate to prevent reinfestation of a pest free area or where there are no other means of preventing fruit fly movement to the PFA, a buffer zone should be established. Factors which should be considered in the establishment of a buffer zone include:

- pest suppression techniques which may be used to reduce the fruit fly population, including selective insecticide-bait, spraying, sterile insect technique, male annihilation technique, biological control, mechanical control, etc.
- host availability, cropping systems, natural vegetation, climatic conditions
- the geography of the area
- capacity for natural spread.

1.2 Public awareness

An important factor in the establishment and maintenance of FF-PFAs is the support and participation of the FF-PFA community, including parties with direct and indirect interests. The PFA status can be maintained only if there is no introduction of infested material. The public and stakeholders should be informed of the importance of establishing and maintaining the pest free status of the area. This helps to achieve compliance with the phytosanitary measures for the FF-PFA. The public awareness and phytosanitary education programme may include:

- permanent or random roadblocks
- posting signs at entry points and transit corridors
- disposal bins
- brochures
- public information programmes
- systems to allow fruit movement
- penalties for non-compliance.

1.3 Documentation and review

The procedures for the FF-PFA should be adequately documented. They should be reviewed and updated regularly. If required, corrective measures should be implemented and documented.

1.4 Record keeping

The records of surveys, detections or outbreaks and results of other operational procedures should be retained at least for 5 years and generally for as long as possible. Such records should be made available to trading partners on request.

1.5 Quality assurance programme

The FF-PFA programme, including the surveillance procedures (both trapping and fruit sampling when used), regulatory controls and corrective action planning should comply with approved procedures. The effectiveness of the programme should be monitored periodically by the NPPO and the trading partner, as appropriate, through quality assurance procedures.

These procedures should include recording information relating to formal delegations of responsibilities to key personnel, for example:

- a management representative with defined authority and responsibility to ensure that the systems/procedures are implemented and maintained appropriately;
- a nominated reference entomologist with responsibility for the authoritative identification of fruit flies to species level;
- other formal delegations where appropriate.

2. Specific Requirements

2.1 Determination of the FF-PFA

The determining characteristics of the FF-PFA include:

- target fruit fly species
- commercial and non-commercial host species
- geographical area (detailed maps showing the boundaries, natural barriers, entry points and host area locations, and, where necessary, buffer zones)
- climate (rainfall, relative humidity and temperature).

2.2 Establishment of the FF-PFA

The following should be developed and implemented:

- surveillance activities for establishment of the FF-PFA
- regulatory controls on movement of host material or regulated articles.

The establishment of buffer zones may also be necessary (see Section 2.1) and it may be useful to collect additional technical information during the establishment of the FF-PFA.

2.2.1 Surveillance activities for establishment

A regular survey programme should be established and implemented. Trapping may be sufficient to determine fruit

fly absence or presence in an area. However, trapping and fruit sampling activities complement each other and fruit sampling is especially required for species that are non-responsive to specific lures.

Surveys should be undertaken for at least 12 months in the FF-PFA using specific trapping and fruit sampling procedures where required in all relevant areas of commercial and non-commercial host plants to demonstrate that the pest is not present in the area. There should be no detections (adult or immature stages) of the target species during the survey period. There are different trapping and fruit sampling regimes for different fruit fly species. Surveys should be conducted using the specific guidelines in Annexes 1 and 2. These guidelines may be revised as trap, lure and fruit sampling efficiencies improve.

The NPPO should establish a quality assurance programme for the survey to verify and document that all procedures are met. There should be identification capability for the target fruit fly species within the country that intends to establish the FF-PFA.

2.2.1.1 Trapping procedures

This section contains general information on trapping procedures. Trapping procedures described apply to the target fruit fly species and to those exotic fruit fly species that do not occur in the country or area. For more detailed information refer to Annex 1. Trapping should consider the following:

Trap type and lures

Different traps have been developed and used over decades to survey fruit fly populations. Traps used for fruit flies are dependent on the target species and the nature of the attractant. The most widely used traps contain para-pheromone or pheromone lures that are male specific. Lures for capturing females are based on food or host odours. Historically, liquid protein baits have been used to catch a wide range of different fruit fly species. Liquid protein baits capture both females and males, with a slightly higher percent of females captured (although identification of the fruit flies can be difficult due to premature decomposition). Dry synthetic protein baits widely used against some fruit fly species are female biased, capture less non-target organisms and, when used in dray traps, prevent premature decomposition of captured specimens.

Trap density

Trap density (number of traps per unit area) is critical for fruit fly surveys and it should be adjusted based on target fruit fly species, trap efficiency, and biotic and abiotic factors. Density may change depending on the programme phase, with different densities required during the establishment of FF-PFA and the maintenance phase. Trap density also depends on the risk associated with potential points of entry. For surveillance for establishment, higher densities are required in commercial production sites and lower densities at points of entry.

Trap deployment (determination of the specific location of the traps)

In a FF-PFA programme, an extensive trapping network should be deployed over the entire area. The trapping network layout will depend on the characteristics of the area, host distribution and the biology of the fruit fly of concern. One of the most important features of trap placement is selecting a proper location and trap site within the host tree. The application of geographic positioning systems (GPS) and global information systems (GIS) are useful tools for management of a trapping network.

Preferred host(s) and fruit maturity

Trap location should take into consideration the presence of the preferred hosts (primary, secondary and occasional hosts) of the target species. Because the pest is associated with mature fruit, the location including rotation of traps should follow the sequence of fruit maturity in host plants.

Trap servicing

The frequency of trap servicing (maintaining and refreshing the traps) during the period of trapping should depend on the:

- longevity of baits (attractant persistency)
- retention system
- rate of catch
- season of fly activity.

Trap inspection (checking the traps for fruit flies)
The frequency of inspection during the period of trapping should depend on the level of fly activity and response periods required at different times of the year and the relative number of target and non-target fruit flies expected to be caught in a trap.

Record keeping
All trapping data should be properly recorded. Records should be kept up to date and should be available for easy retrieval.

Identification capability
NPPO's should have in place adequate infrastructure and trained personnel to identify captured specimens of the target species in an expeditious manner.

2.2.1.2 Fruit sampling procedures
Fruit sampling complements trapping procedures in establishing a FF-PFA. The following factors should be considered when using fruit sampling (see also Annex 2), especially with fruit flies that are not responsive to specific lures:

Host preference
Fruit sampling should take into consideration the presence of primary, secondary and occasional hosts of the target species.

Targeting high risk areas
Fruit sampling should be targeted to areas likely to have presence of infested fruits such as urban areas, abandoned orchards, rejected fruit at packing houses, fruit markets and sites with a high concentration of primary hosts. The sequence of hosts that are likely to be infested by the target fruit fly species in the area should be used to target fruit sampling areas.

Sample size
Factors to be considered include:
- The sample size should be based on a statistical study to ensure samples provide an adequate level of confidence of fruit fly detection within the host commodity.
- The sample size, the number and weight of fruits per sample should be planned based on the availability of primary host material in the field.
- Samples should include fruits with symptoms on trees, fallen or rejected fruit at packing facilities, where appropriate.

Timing
Fruit sampling should be a continuous operation covering the full fruiting season following maturation phenology of the host(s).

Procedures for processing fruit
Fruit samples collected in the field should be brought to a facility for holding, fruit dissection, pest recovery and identification. Fruit should be labeled, transported and held in a secure manner to avoid mixing fruits from different samples.

Identification capability
NPPOs should have in place adequate infrastructure and trained personnel (or access to such personnel) to identify fruit fly immature stages and emerged adults of the target species in an expeditious manner.

Record keeping
All fruit sampling data should be properly recorded to permit trace-back of detections. Records should be kept up to date and should be available for easy retrieval.

2.2.2 Regulatory controls on the movement of host material or regulated articles
Regulatory movement controls for host materials or regulated articles should be implemented to prevent the entry

of target pests into the FF-PFA during the establishment phase. These controls depend on the assessed risks (after identification of likely pathways and regulated articles) and may include:

- listing of the target fruit fly species on a quarantine pest list
- publishing of regulations, including restriction of the movement of certain products within areas of country or countries and/or buffer zones, if necessary
- specification of import requirements into a country or area
- inspection of host materials and regulated articles, examination of relevant documentation as appropriate and, where necessary for cases of non-compliance, the application of appropriate non-compliance measures (e.g. treatment, reshipment or destruction).

2.2.3 Additional technical information for establishment

Additional information may be useful during the establishment phase of FF-PFAs. This includes:

- historical records of detection, biology and population dynamics of the target pest, and survey activities for the designated target pest(s) in the FF-PFA
- the results of phytosanitary measures taken as part of actions following detections of fruit flies in the FF-PFA
- records of the commercial production of host crops in the area, an estimate of non-commercial production, and the presence of wild host material
- lists of the other fruit fly species that may be present in the FF-PFA.

2.3 Verification and declaration of pest freedom

The NPPO verifies the fruit fly free status of the area (see ISPM No. 8: *Determination of pest status in an area*) by checking the compliance with the procedures set up in accordance with this standard (surveillance and regulatory controls). The NPPO, through its national or sub-national regulatory process, declares the establishment of the FF-PFA and notifies trading partners as appropriate.

In order to be able to verify the fruit fly free status in the area and for purposes of internal management, the continuing FF-PFA status should be checked after the PFA has been established and any phytosanitary measures for the maintenance of the FF-PFA have been put in place.

2.4 Maintenance of the FF-PFA

In order to maintain the FF-PFA status the NPPO should continue the operation of the surveillance activities and regulatory controls.

2.4.1 Surveillance for maintenance of the FF-PFA

After verifying and declaring the FF-PFA, the official surveillance programme should be continued at a level assessed to be required for maintenance of the FF-PFA as long as the FF-PFA is operational. Regular technical reports (for example monthly) of the survey activities should be generated. This is the same as for establishment of the FF-PFA (see Section 2.2) with differences in density and trap locations dependent upon the assessed level of risk of introduction and establishment of the target species. In this case (i.e. surveillance for maintenance), lower densities are required in commercial production sites and higher densities in points of entry.

2.4.2 Regulatory controls on the movement of host material and regulated articles

These are the same as for establishment of the FF-PFA (see Section 3.2.2).

2.4.3 Corrective actions (including response to an outbreak)

The NPPO should have prepared plans for corrective actions that may be implemented if the target pest is detected in the FF-PFA (see Annex 3). These should include:

- criteria for the declaration of an outbreak/incursion and the determination of the outbreak area
- criteria for reinstatement of a FF-PFA after an outbreak
- procedures for responding to post-harvest interceptions
- criteria for initiating further surveillance
- rapid identification of target pests
- delimiting survey (trapping and fruit sampling)
- control measures
- notification of trading partners as appropriate.

A corrective action plan should be initiated within 72 hours of the detection (of an adult or immature stage of the target pest).

2.5 Suspension, termination and reinstatement of a FF-PFA

2.5.1 Suspension and termination

The status of the FF-PFA should be suspended or terminated when an outbreak of the target pest occurs or procedures are found to be faulty, for example inadequate host movement controls.

If the criteria for an outbreak are met, this should result in the implementation of the corrective action plan as specified in this standard and immediate notification of trading partners (see ISPM No. 17: *Pest reporting*). If the control measures are not effective and the pest becomes established in the area, the status of the FF-PFA should be terminated. The whole or part of the FF-PFA may be suspended or revoked. Where a suspension is put in place, the criteria for lifting the suspension should be made clear. Trading partners should be informed of any change in FF-PFA status.

2.5.2 Reinstatement

Reinstatement may take place:

- in the case of detection of a fruit fly outbreak, only after having no further detections for at least three life cycles of the target pest species or when the conditions for establishment of the FF-PFA have again been achieved.
- in case of a fault in the procedures, only when the fault has been corrected.

ANNEX 1

GUIDELINES ON TRAPPING PROCEDURES

1. Trapping survey objectives and applications

The three objectives of trapping surveys are:

- detection survey - to determine if species are present in an area.
- delimiting survey - to determine the boundaries of an area considered to be infested or free from a pest.
- monitoring survey – an ongoing survey to verify the characteristics of a pest population.

Trapping surveys are applied:

- In infested areas**:** to determine presence of the target species and to monitor established fruit fly populations.
- For suppression**:** to measure the efficacy of control measures such as bait sprays, sterile insect technique (SIT), biological control and male annihilation technique (MAT) in an infested area to reduce the fruit fly population and thereby limit spread. Suppression is a process that is applied to result in an area of low pest prevalence.
- For eradication: to measure the efficacy of control measures such as bait sprays, SIT, biological control and MAT, to eliminate a pest from an area. Eradication is a process applied to reach free areas.
- For exclusion**:** to determine the presence of species that are under exclusion measures and to confirm or reject the pest free area status. Exclusion is a process applied to minimize the risk of introduction or re-introduction of the target species in a pest free area.

2. Traps and attractants used for fruit flies

Traps used for fruit flies are dependent on the nature of the attractant. The most widely used traps contain para-pheromone lures that are male specific. The para-pheromone trimedlure (TML) captures medfly (*Ceratitis capitata*) and Natal fruit fly (*Ceratitis rosa*). The para-pheromones methyl-eugenol (ME) and cuelure (CUE) captures a large number of *Bactrocera* species. Para-pheromones are generally highly volatile, and can be used with panels, delta-traps and bucket-type traps. TML and ME have controlled-release formulations providing a longer lasting attractant for field use. Attracted flies are retained in panel and delta traps using a sticky material. Para-pheromones may also be mixed with a sticky material and applied to the surface of the panels. Retention systems for bucket traps are usually a form of a volatile toxicant such as DDVP (2,2-Dichlorovinyl dimethyl phosphate) and malathion, although some of these are repellent at higher doses. For use of synthetic lures water is used with a surfactant to retain attracted flies. The percentage of females captured with a para-pheromone trap is extremely low.

Lures for capturing female fruit flies are based on food or host odours. Historically, liquid protein baits have been used to catch a wide range of different fruit fly species. Liquid protein baits capture both females and males, with a higher percent of females captured. These liquid baits generally are not as sensitive as the para-pheromone bait. In addition the usage of liquid baits results in capturing high percentages of non-target insects. Ammonium carbonate (AC) and/or ammonium acetate (AA) lures are used for several *Rhagoletis* species. A two component combination of AA and putrescine (PT) are attractive for Mexican fruit fly (*Anastrepha ludens*) and Caribbean fruit fly (*Anastrepha suspensa*). The addition of a third component, trimethylamine (TMA) results in a highly attractive female lure for medfly which is used in early detection trapping networks.

The two and three component synthetic lures described above are generally used in plastic McPhail traps, although they can be used with a variety of other traps. Ammonium acetate and ammonium carbonate, when used for capture of *Rhagoletis* species, are used with red sphere traps or yellow panel traps coated with a sticky material. A synthetic attractant based on host fruit volatiles is currently used for detection of apple maggot fly (*Rhagoletis pomonella*). The chemical, butyl-hexanoate (BuH), is used with a red sphere trap coated with a sticky material, typically placed at a short distance from the trap.

2.1 Trap descriptions

2.1.1 Jackson trap (JT)

The body of a standard Jackson trap (JT) is a delta shaped object made of waxed cardboard material. The body parts include:

1) white or yellow rectangular piece of waxed cardboard insert floor. The insert is covered with a thin layer of sticky material used to trap flies once they land inside the trap body,
2) polymeric plug that holds the lure and
3) wire hook placed at the top of the trap body.

This trap is mainly used with para-pheromone lures (mixed with an insecticide) to capture male fruit flies. The most common lures used with the JT are: trimedlure (TML), methyl eugenol (ME) and cuelure (CUE). The JT is one of the most economic traps commercially available. It is easy to carry, handle and service, providing the opportunity of servicing a greater number of traps per man-hour than other commercial traps.

2.1.2 McPhail trap (McP)

The conventional McPhail trap (McP) is a transparent glass or plastic pear shape invaginated container. The trap parts include: a) rubber cork or lid that seals the upper part of the trap and b) wire hook to hang traps on tree branches.

This trap uses a liquid food bait, based on hydrolyzed protein or torula yeast tablets. Food lures are generic by nature and, besides the target fruit fly species, traps tend to catch a wide range of other tephritid and non-tephritid flies as well as other insects.

2.1.3 Plastic two-piece McPhail trap

This trap consists of a two piece plastic cylinder shape invaginated container. The upper part and base of the trap can be separated allowing the trap to be serviced and re-baited. The transparent upper part of the trap contrasts with the yellow base enhancing trap ability to catch fruit flies. This trap can be used with the liquid protein bait or with the dry synthetic lure. This trap works on the same principle as the McP.

2.1.4 Steiner trap

The Steiner trap is a horizontal, clear cylinder with a large opening at each end. The lure is added by suspending, from the centre of the trap, a cotton wick soaked in 2-3 ml of a mixture of a chemical lure and an insecticide, usually malathion or dichlorvos. The insecticide is added to avoid flies escaping or to avoid predation of captured flies. If the insecticide is not mixed with the lure, it is added on a strip of filter paper and placed in the trap.

2.1.5 Tephri trap

The Tephri trap is a McPhail type trap. It has a yellow base and a clear top, which can be removed to facilitate servicing. This trap has entrance holes around the top of the periphery of the yellow base, which has an invaginated opening in the bottom. Inside the clear top is a platform for pla cement of attractants.

It is used for trapping medflies when baited with either hydrolyzed protein at 9% concentration, or TML or Cuelure in a plug or liquid. If the trap is used without the side holes, the insecticide will not be necessary. However, when used with side holes, an insecticide solution or a DDVP strip will be needed to avoid escape of captured insects

2.1.6 Open bottom dry trap (OBDT)

This trap is an open-bottom cylindrical dry trap that can be made from opaque green plastic or wax-coated green cardboard. It has a transparent top, three equally-spaced holes around the circumference of the cylinder midway between the ends, an open bottom, and is used with a sticky insert. It is used with the synthetic female fruit fly lures in areas where more expensive traps cannot be used.

The food-based synthetic chemical attractant can be used to capture female and male medflies. The synthetic female fruit fly lures are attached to the inside walls of the cylinder. Servicing is easy because the sticky insert permits removal and replacement similar to the inserts used in Jackson traps.

2.1.7 Yellow trap

This is an open yellow cardboard trap, rectangular in shape. The rectangular cardboard is covered, on both sides, with a thin layer of sticky material, with the lure mixed into the coating or attached to the face of the trap. A wired hook, placed on top of the trap body, is used to hang the trap from the tree branches. This trap uses the male specific parapheromone lures -TML, ME and cuelure.

Its use is recommended for the post suppression and fly-free phases where highly sensitive traps are required. This trap should not be used in areas subjected to mass release of sterile flies due to the amount of released flies that would be caught.

Table 1. List of lures and attractants used in fruit fly traps

Common name	Acronym	Chemical	Formulation	Field longevity*

Parapheromones				(weeks)
trimedlure	TML	*tert*-butyl 4 (and 5)-chloro-2-methylcyclo-hexane-1-carboxylate	Polymeric plug/panel	6
			Laminate	6
			liquid	2
methyl eugenol	ME	Benzene, 1,2-dimethoxy-4-(2-propenyl)	Polymeric plug/panel	6
			Liquid	2
cuelure	cuelure	4-(p-hydroxyphenyl)-2-butanone acetate	Liquid	2
Pheromones				
papaya fruit fly	PFFP	3-methyl-1-pyrazine	Membrane-based	4
olive fly (spiroacetal)	OFP	(1,7)-dioxaspiro-[5,5]undecane (olean)	Polymer	4
Food-based attractants				
torula yeast/borax	TY	Torula yeast/borax	Pellet	1
protein derivatives	HP	hydrolized protein	Liquid	1
ammonium acetate	AA	ammonia + acetic acid	Membrane-based	6
			Liquid	1
			Polymer	4
ammonium (bi)carbonate	AC	Ammonia	Membrane-based	6
			Liquid	1
			Polymer	4
ammonium salts	A	Ammonia	Salt	
putrescine	Pu	1,4 diaminobutane	Membrane-based	6
trimethylamine	TMA		Membrane-based	6
butyl hexanoate	BuH		Vial	2

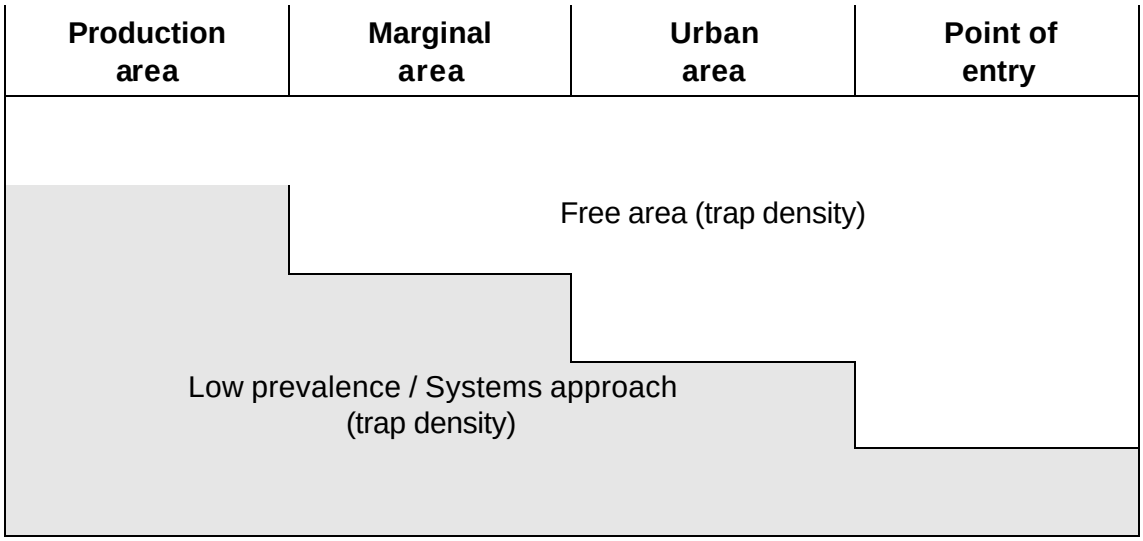
*Based on half-life

3. Trap density for establishment and for maintenance

Trap density is a critical factor for establishment and maintenance of fruit fly free areas and low prevalence areas. The densities need to be adjusted based on many factors including: trap efficiency, lure/attractant efficiency, location regarding type and presence of host, climate, topography and programme phase.

Densities may also vary along a gradient from production to marginal areas, to urban areas and points of entry. For example, trapping densities in an area of low pest prevalence, where the presence of the target species is known, should be higher in the production field and decrease toward points of entry (Figure 1). In a designated pest free area, the reverse occurs: a higher density is required at points of entry and lower density in commercial orchards

Figure 1. Diagram to illustrate trap density according to pest free area or area of low pest prevalence



3.1 Trapping densities according to the type of target areas

Trapping densities vary from 0.25 to 50 traps per square kilometer depending on the factors mentioned above, mainly the FF-PFA programme phase (i.e. establishment or maintenance) and area being monitored.

Densities are also dependant on associated survey activities, such as fruit sampling to detect immature stages. In those cases where trapping surveys are complemented with fruit sampling activities, trap densities should be lower than the recommended densities.

4. Layout of trapping network

In area-wide suppression/eradication programs, an extensive trapping network has to be deployed over the entire area subjected to control actions. The trapping network layout will depend on the intrinsic characteristics of the area. In areas where continuous compact blocks of commercial orchards are present, and in urban and suburban highly populated areas where hosts exists in backyards, traps are arranged in a grid system with a uniform trap distribution. In areas with scattered commercial orchards, rural or low populated villages with backyard fruit hosts, and in commercial and wild host marginal areas, trap network arrays are normally linear with a distribution pattern, following roads that provide access to host material.

5 Trap placement

It is of vital importance to have a list of the primary, secondary and occasional fruit fly hosts, their phenology, distribution and abundance. With this basic information, it is possible to properly place and distribute the traps in the field and it also allows for an effective planning of a trap rotation programme. Traps have to be rotated following the maturation phenology of the main fruit hosts. By rotating the traps it is possible to follow the fruit fly population throughout the year and it also increases the number of sites being checked for fruit flies.

One of the most important factors of trap placement is selecting a proper trap site. When possible, pheromone traps should be placed in mating areas. Fruit flies normally mate in the crown of a fruit host tree or close to the host trees with some light and on the upwind side. Other suitable trap sites are resting and feeding areas in trees that provide shelter and protect flies from strong winds and predators. Protein traps should be placed close to fruit host trees, in a shady area. In this case, traps should be placed in primary hosts during their fruit maturation period. In the absence of primary hosts, secondary hosts should be used. In areas with no hosts identified as potential fruit fly pathways, traps should be placed in trees that can provide shelter, protection and food to adult fruit flies. Traps should be placed 4-6 feet from the ground in the middle to the top part of the host tree canopy and oriented towards the upwind side. Traps should be protected from direct sunlight, strong winds and dust. It is of vital importance to have the trap entrance clear from twigs and leaves in order to allow proper lure airflow and an easy access for the fruit flies.

6 Trap mapping

Once traps are placed in carefully selected sites at the right density and distributed in an adequate array, the location of the traps has to be recorded. The application of the geographic positioning systems (GPS) and geographic information systems (GIS) technology in management of trapping network has proven to be a very powerful tool. The GPS allows each trap to be geo-referenced through geographical coordinates, which are then used as input information in the GIS. A database of all traps with their corresponding coordinates is kept, together with the records of trap services, re-baiting, trap catches, etc. The GIS provides high resolution maps showing the exact location of each trap and other valuable information such as exact location of fly finds (detections or outbreaks), historical profiles of the geographical distribution patterns of the pest, size of the populations in given areas, etc. This information is extremely useful for effective planning of control activities such as bait sprays and sterile fly releases and for being more cost-effective in their application. When GIS is not available, a map or sketch of the trap location and the area around the traps should be prepared. The references of the trap location should include visible land marks; in the case of traps placed in suburban and urban areas in backyard hosts, references should include the full address of the property where the trap was placed. The trap reference should be clear enough to allow trapping inspectors, control brigades and supervisors to find the trap with ease.

7 Trap service intervals

Trap service and re-bait intervals are specific to each trap system. However, the following guidelines are effective for most of the current traps commercially available. Capturing flies will depend, in part, on how well the trap is serviced. Servicing a trap has to be a clean and quick procedure. Lures (pheromones or food lures) have to be used in the exact amounts and replaced at the recommended time period. Commercially available pheromone lures are contained in dispensers or plugs at amounts that are standard for each different type of lure. However, the release rate will vary with different environmental conditions. In hot and dry areas The release rate is high in hot and dry areas, and low in cool and humid areas. Service interval should be adjusted according to the prevailing environmental conditions. Food lures in liquid form have to be diluted in water before use. In hot and dry climates, traps have to be re-baited twice per week, whereas under hot and humid, or temperate, conditions the re-bait interval is once per week. When liquid lures are used (e.g. liquid trimedlure or hydrolyzed proteins), it is important to avoid spillage or contamination of the external surface of the trap body. This would reduce the chances of flies entering the trap. For traps that use a sticky insert to capture flies, it is important to avoid contaminating areas in the trap that are not meant for catching flies. This also applies for leaves and twigs that are in the trap surroundings.

In general, the estimated number of traps serviced per day per person for most of the traps is 50. The exception is [PMT] baited with liquid protein that requires more time. The number of traps typically serviced per person per day is 30. These values vary depending on host density, environmental and topographic conditions.

8 Trap record keeping

The establishment and maintenance of fruit fly pest free areas should be adequately documented and periodically reviewed. The documentation should include:

- trap location and relocation
- trap capture for at least last 24 months
- trap mapping and area delimitation.

If detection of the target species has occurred, the phytosanitary measures taken and the results of those measures should be documented.

9 Quality control for trapping procedures

A quality control programme for the trapping activities and record keeping should be established. The key elements of the quality control programme should include:

- verification of lure efficacy
- placement and recovery of marked target flies
- regular reviews of survey documentation
- audits of trap placement and servicing
- confirmation of identifier competency
- record keeping procedures.

10 Flies per trap per day (FTD)

The flies per trap per day is a population index that estimates the average number of flies captured in one trap in one day that the trap is exposed in the field. The function of this population index is to have a relative measure of the size of the adult pest population in a given space and time. It is used as baseline information to compare the size of the population before, during

and after the application of a fruit fly control programme. The value of the FTD in the fruit fly free area must be equal to zero in order to maintain its phytosanitary status. Its value is the result of dividing the total number of captured flies by the product obtained from multiplying the total number of serviced traps by the average number of days the traps were exposed. The formula is as follows:

$$FTD = \frac{F}{T \times D}$$

where,
F = total number of flies
T = number of serviced traps
D = average number of days traps were exposed in the field

Reference document:
Trapping Guidelines for Area-Wide Fruit Fly Programmes. 2003. IAEA, Vienna.

ANNEX 2

GUIDELINES FOR FRUIT SAMPLING

1. Background

In fruit fly control programmes, fruit sampling is a pertinent method used to help assess the age structure of a fruit fly population, host sequence and seasonal abundance. It is also used as a detection tool during eradication and fly free phases.

In sterile mass release programmes, fruit sampling plays a predominant role as the most reliable method for determining the occurrence of the target pest and for evaluating the effectiveness of the control measures applied.

In sterile fly release areas, fruit sampling relegates trapping to a second place, especially due to the likelihood of error in adult identification through the capture of hundreds of thousands of sterile flies (Enkerlin *et al*. 1996).

Under certain conditions, fruit sampling can provide better information than trapping for delimitation of established wild populations, although, in fly-free areas it is less efficient in detecting newly introduced populations. However, it can complement trapping by confirming the presence and/or establishment of a population and by providing information on the magnitude of an outbreak.

Fruit sampling is also a necessary tool to identify the hosts of fruit fly species, in case the fly is a lesser-known species or if a fruit fly outbreak occurs in a new geographic area. As fruit flies are highly adaptive, they can change their choice of host plants, and this can only be detected through the collection of fruits.

2. Scope

The fruit sampling procedures in this document cover the different phases of a programme aimed at developing fruit fly pest free areas (FF-PFAs), from pre-suppression/eradication activities to establishment of the area. However, relevant to this standard are only those sampling procedures applied as part of the certification process during the establishment of a FF-PFA. Fruit sampling during maintenance of the FF-PFA is applied as part of a corrective action plan thus it is not described in this document.

3. Fruit Sampling Objectives

The aim of field activities for the fruit sampling, at the initial stages (pre-eradication) of an area-wide control programme, is to produce baseline information (Table 1). The information includes primary, secondary and occasional hosts of fruit flies in the area, as well as the phenology and distribution of the respective hosts in the area under consideration. It also provides information on the pest's host range, host sequence and fruit fly population structure.

During the suppression and eradication phases, fruit sampling becomes an evaluation tool of the control activities by measuring fruit infestation levels. During the post-eradication phase (certification) and fly-free phase (maintenance), fruit sampling becomes a detection tool (Table 1). Primary hosts are collected in the most sensitive geographical areas. The responsibilities of field sampling end with the delivery of the collected samples to the fruit-processing laboratory. The purpose of the laboratory is to study the fruit samples by processing the fruits to rear fruit fly larvae to the adult stage for easy identification or to dissect the fruit and identify larvae if capabilities for species identification at the larval stage exist.

Table 1. Fruit sampling applications related to the programme objective and operational phase

Fruit Sampling Application	Objective	Programme phase
General fruit sampling	Baseline information	Pre-eradication
Systematic fruit sampling	Evaluation of suppression	Suppression
Systematic fruit sampling	Evaluation of eradication	Eradication
Selective fruit sampling	Certification of FF-PFA	Post-eradication
Corrective action plan	Maintenance	Fruit fly free area

4. Fruit Sampling Methods and Procedures

There are basically three sampling applications that are dependant of the objective and programme phase (Table 1): general

sampling, systematic sampling and selective sampling.

4.1 General sampling

This type of sampling provides mainly qualitative information and is of fundamental importance. It consists of collecting, throughout the year, the widest range of fruits that could be infested by fruit flies with no special emphasis on a particular fruit, although with a slight preference for those fruits that have been infested in other countries, dealing with the same fruit fly species and having similar ecological conditions.

The primary objective of this type of sampling is to identify true hosts in the area and to determine host susceptibility, host range and infestation gradients. Because this fruit sampling is done extensively throughout the year it also provides information on host distribution, density and phenology. All this information is used for proper planning of year round fruit sampling activities.

During the preparation stage of a programme, such as for an eradication campaign, this sampling has to be carried out for at least one year so that it can provide information regarding the different phenological stages of the fruit hosts. This sampling can be considered completed when sufficient information on relative abundance, temporal and spatial distribution of the pest has been obtained. This must definitely precede the start of eradication actions, during which the systematic fruit sampling is enforced. The general sampling is extensive by nature and only small amounts of fruit sampling are collected. Fruit samples have to be continuously collected with a time interval of 14 days from the entire area throughout the year (Table 2). For number of samples and kilograms per unit surface see Table 3.

Table 2. Fruit sampling frequencies.

Fruit sampling application	**Frequency (days)**
General fruit sampling	14
Systematic fruit sampling	7 to 14
Selective fruit sampling	7
Corrective action plan	1 to 3

Table 3. Fruit sampling levels per km^2

Programme Phase	**Fruit orchards**		**Urban and suburban areas**		**Other areas with scattered hosts**	
	samples[1]	kg[1]	samples	kg	samples	kg
Pre-eradication	3	6	2	4	1	2
Suppression (chemical control)	4	8	3	6	2	4
Eradication (autocidal control)	6	12	5	10	4	8
Post-eradication	10	20	9	18	8	16
Fly free area	Only applied as a result of an adult detection as part of the corrective action plan.					

[1] Average figures used in operational programmes

4.2 Systematic sampling

This type of sampling is based on information produced by the general sampling and is carried out in areas subjected to control procedures during the suppression/eradication phase.

The objective of this sampling is to keep a close and systematic surveillance on wild fly populations. One of its features is that it uses a selective, hierarchical procedure for the known hosts, based on the degree of preference. In this way, for sampling, priority is given to the most preferred hosts (primary hosts) and secondly only to other hosts considered to be secondary or occasional hosts. If there are no known hosts at the sampling location, any type of fruit that potentially can be infected by fruit flies can be collected. Fruit samples have to be continuously collected with a time interval of 7 to 14 days from the entire area throughout the year (Table 2).

This type of fruit sampling is much more intensive than the general sampling. For number of samples and kilograms per unit surface see Table 3.

4.3 Selective sampling

This sampling focuses on the collection of the preferred host(s) during its maturation season. Preferred hosts are sometimes called "trap-hosts", since the likelihood of detecting the pest is high even when populations are at low levels. This type of sampling is carried out and during the post-eradication phase in areas under verification of eradication status as part of the certification process. Fruit samples have to be collected from the selected crops and sites every 7 days during the fruit maturation period (Table 2). For number of samples and kilograms per unit surface see Table 3.

During the maintenance phase fruit sampling is not conducted on a continuous basis in the free area. In this case selective fruit sampling activities will be implemented after the detection of an adult in a trap. This is explained in more detail in Annex 3 on corrective action plans.

Given the high degree of preference for these hosts, special emphasis should be placed on markets and packing facilities where fruits are selected and dumped when damaged. Selective sampling can also be carried out on trap-host(s) especially during the time when the host trees are bearing a small number of fruits (at the beginning and/or at the end of the fruiting season). This greatly increases the probability of detecting the pest. If the trap-crop is industrially processed or packed within the sampling area, it is better to take samples directly from the processing and packing centers. In this case a set statistical fruit sampling is conducted on each fruit load during the selection process. Generally, fruit that does not satisfy quality standards is discarded and sold in the domestic market or disposed and can be used for sampling purposes, substantially increasing the probabilities of detecting the pest. The origin of this fruit can be tracked back to the level of the field lot where the fruit was harvested by consulting the records of the fruit load. Records need to be maintained at all times by the personnel at the packing facility and presented upon request.

In case trap-crops are of commercial value for low-income families, purchase of this fruit is advisable. Confiscation of such fruit through phytosanitary regulations, even in small amounts, can cause social problems and damage the public image and acceptability of the campaign.

5. Fruit Sampling Procedures

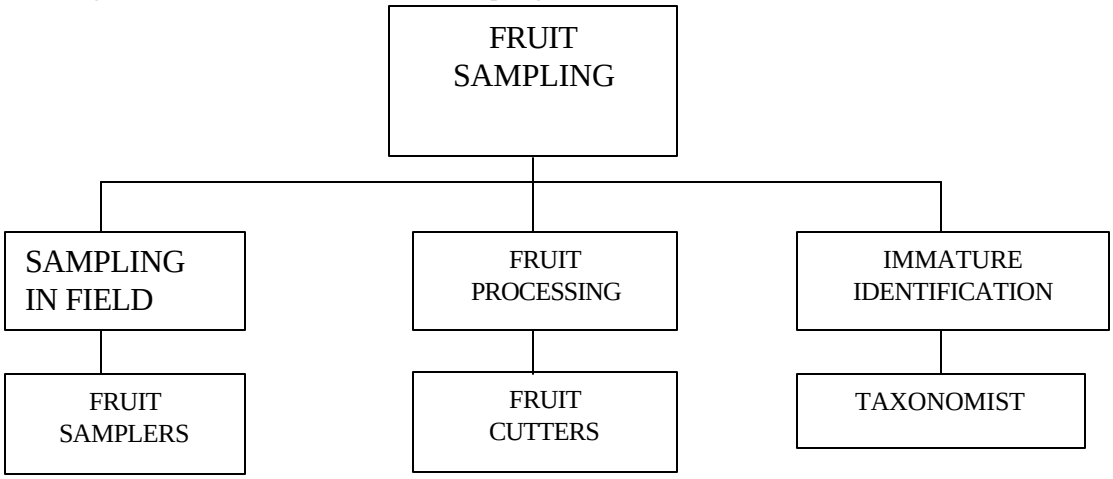
5.1 Division of sampling area and location of sampling sites

It is of fundamental importance to establish an effective method to divide the sampling area for easy location of the sampling sites. Using maps of preferably a scale of 1:50,000 the sampling area is divided into quadrants of 10 x 10 km (or 100 km^2) following international coordinates used in conventional cartography. The quadrant is in turn subdivided into four sub quadrants. A thorough inspection for determination of likely sites for fruit sampling within the sub quadrant needs to be conducted. Once sampling sites are identified they need to be geo-referenced. The availability of the Geographical Positioning System (GPS) greatly facilitates determination of geographical coordinates for identification of sampling sites. The identification number of each site is used for record keeping, feeding databases and for easy location of the site in case of the detection of an immature stage of the pest.

5.2 Organization

Fruit sampling can be done together with trapping activities in the case of the systematic fruit sampling. However it can also be a separate activity in a programme. Fruit sampling does not necessarily follow the trapping routes especially in the case of general and selective fruit sampling. The standard organizational structure for fruit sampling activity in operational programmes is presented in Figure 1.

Figure 1. Organizational structure of the fruit sampling section:



Equipment for fruit collection includes:

- suitable vehicle
- fruit bags preferably made of cotton or fruit holding boxes, either plastic or polyethurane (the latter material will protect the fruit from heat)
- fruit cutter to collect fruits from the tree
- labels with following information (date, quadrant, sub quadrant**,** GPS position as WPT (Way point), common name of host, number of fruits, kilograms and name of technician)
- screen to cover the boxes (some fruit fly larvae jump; and for boxes with low sides, larvae can end up in another sample by just jumping)
- absorbent material to place in the boxes under the fruit (this will absorb the juice coming out of the fruit, so the fruit fly larvae will not drown)
- recording sheet and maps of the area.

5.3 Fruit collection procedures

To start a sampling programme the following information is of importance:

- infra structure and topography of the area (visit area, maps)
- biology and ecology of the pest
- phenology of the wild and cultivated hosts and their occurrence
- composition of the vegetation
- fruit marketing centers, fruit growing areas, packing facilities.

Sampling should be done in the entire area; if vehicles cannot be used, samples have to be collected on foot or on horse. This does reduce the amount of sampling as it takes much more time.

In taking samples, the available information on the biology and habits of the fly, damage symptoms, as well as pest population levels and distribution should be used. In other words, samples are not to be taken at random but on the basis of certain technical criteria and empirical knowledge.

Fruit should not be collected in plastic bags. Although this is easily available, it might cause the larvae to die due to heat,

shortage of oxygen or simply by drowning in the fruit juice in the bag.

Samples can be collected either from the ground or from the tree. In the case of fruit collected from the ground, only recently fallen fruits should be used, as fruit fly larvae might have already left older fruits to pupate in the soil.

The size of a sample can vary widely. This will depend on availability and volume of the fruit sampled. It can range from 0.5 kg in the case of coffee berries to 5 kg in case of a larger fruit like grapefruit. Excessive sample sizes should be avoided, as they will make farmers or property owners unsatisfied with the programme.

Each sample should be properly labeled. The data on the label should be such that the original location of the fruits can easily be retraced in case the fruits are infested with the target fruit fly.

Fruit sampling can also give information on the fruit fly parasitism rate in that area, as on infestation by other fruit fly species.

In an eradication programme, where the fly is already low in numbers, fruit sampling should be directed to the primary hosts. Damaged fruits of these fruit species should be preferably sampled. Table 4 indicates major, secondary and occasional hosts for a number of important fruit fly species.

Fruit should be collected ripe. Fruit maturity and the development of eggs and larvae in the fruit are often in synchrony. Females select fruits with a suitable degree of ripeness in order for the offspring to complete its development. Unripe fruits should not be collected.

6. Fruit processing

After the fruit samples are brought in from the field, there are several ways to process it:

6.1 Fruit cutting

Each fruit is cut for careful observation, if fruit fly larvae are present in the fruits. Especially in an eradication campaign, immediate action must be taken if larvae are found. Each fruit is dissected on the basis of its color and consistency, which is related to the degree of ripeness. The development of the larvae is closely related to the fruit ripeness. The person dissecting the fruit should be well trained to recognize larvae in infested fruit, as well as distinguishing between Diptera larvae and larvae of other insect orders, such as scavenger flies and beetles. The larvae are placed in separate vials containing water and labeled with their respective sample number; and then sent to the taxonomist. The person dissecting fruits should take a 15-30 minutes break after 2-3 hours of work in order to reduce or avoid possible errors.

6.2 Fruit holding and maturing

Equipment for fruit holding includes:

- Fruit holding boxes with screens on the side and top for ventilation either wooden plastic or polyethurane (this last material will protect the fruit from heat)
- Absorbent material to place in the boxes under the fruit (this will absorb the juice coming out of the fruit, so the fruit fly larvae will not drown)
- Plastic or metallic trays for fruit dissection
- Other material (entomological tweezers, glass vials, labels, etc)
- Data sheets.

Each fruit is placed in a container to allow for further ripening, so that the fruit fly larvae get a chance to mature and pupate. This is the easiest method to determine the identity fruit fly species present and/or the parasitism rate of fruit flies. The time needed for the fruit to be stored, so as to have good fly emergence, depends on the fruit species, and on the fruit fly in question.

Table 4. Major fruit flies and their hosts

Family	Anacardiaceae						Car	Chr	Com	Cuc	Ebe	Gut	Jug	Lau	Mal	Moraceae		Myrtaceae				Mus	Ole	Oxa	Pal	Pas	Rha	Rosaceae						Rub	Rutaceae								Sapi	Sapo			Solanaceae			
Scientific name	*Anacardium occidentale*	*Mangifera indica*	*Spondias cytherea*	*Spondias dulcis*	*Spondias mombin*	*Spondias purpurea*	*Carica papaya*	*Chrysobalanus icaco*	*Terminalia catappa*	*Cucurbits*	*Diospyros spp.*	*Garcinia spp.*	*Juglans sp.*	*Persea americana*	*Malpighia punicifolia*	*Artocarpus altilis*	*Artocarpus spp.*	*Eugenia uniflora*	*Psidium guajava*	*Syzygium jambos*	*Syzygium samarangense*	*Syzygium samarangense*	*Musa paradisiaca*	*Olea europaea*	*Averrhoa carambola*	*Phoenix dactylifera*	*Passiflora sp.*	*Zyzyphus jujuba*	*Eriobotrya japonica*	*Malus domestica*	*Prunus domestica*	*Prunus persica*	*Prunus sp.*	*Pyrus communis*	*Coffea arabica*	*Citrofortunella mitis*	*Citrus aurantium*	*Citrus limetoides*	*Citrus maxima*	*Citrus paradisi*	*Citrus reticulata*	*Citrus sinensis*	*Fortunella margarita*	*Sargentia greggii*	*Litchi sinensis*	*Casimiroa edulis*	*Manilkara sapota*	*Pouteria sapota*	*Lycopersicum esculentum*	*Capsicum annuum*	*Solanum melongena*	*Solanum spp.*
Anastrepha fraterculus																																															
A. grandis																																															
A. ludens																																															
A. obliqua																																															
A. striata																																															
A. suspensa																																															
Bactrocera carambolae																																															
B. caryeae																																															
B. correcta																																															
B. cucurbitae																																															
B. cucumis																																															
B. dorsalis **																																															
B. kandiensis																																															
B. latifrons																																															
B. minax																																															
B. musae																																															
B. neohumeralis																																															
B. occipitalis																																															
B. oleae																																															
B. papayae																																															
B. philippinensis																																															
B. pyrifoliae																																															
*B. tau****																																															
B. tryoni																																															
B. tsuneonis																																															
B. umbrosa																																															
B. xanthodes																																															
B. zonata																																															
Ceratitis capitata																																															
Ceratitis rosa																																															
Dacus ciliatus																																															
D. frontalis																																															
Rhagoletis cerasi																																															
R. completa																																															
R. indifferens																																															
R. pomonella																																															
Toxotrypana curvicauda																																															

major host
secondary host
occasional host
no host

Fleshy and thin skin fruits, such as guava, cherry and mango, ripen quickly so they are kept 5 to 10 days, in order for all larvae to pupate. Fruits with more persistent skin like citrus may have to be stored for as long as 15 days, before larvae are mature enough to emerge and pupate.

During the rainy season or under high relative humidity in the tropics, the fruits can be treated with a 2-5 % sodium benzoate solution (one-minute submergence) in order to slow down the development of saprophytic microorganisms (i.e. fungi and bacteria).

The type of container will depend on the size of the fruit sample. Jars may be used in case of small fruits/samples; but for bigger samples, plastic trays should be used.

The bottom of the container should be covered by a medium suitable for pupation. This is done to provide the larvae with a suitable pupation medium, and to absorb excessive moisture from the fruits. The medium used can be sawdust, sterilized sand or vermiculite.

Inside the container, a mesh wire screen can be placed several centimeters above the medium, which will hold the fruit, but will allow the larvae to pass through to pupate in the medium.

The containers should be covered with a fine screen or a cloth to keep out the vinegar flies, *Drosophila* species.

Each container should have a serial number, which is registered and any information pertaining to infestation, as well as emerging flies and/or parasitoids can be recorded accordingly in a fruit control data sheet. All emerging flies, pupae and/or parasitoids are placed in vials together with the respective sample number and should be sent to the taxonomist for proper identification.

7. Record Keeping

In order to use the results of the fruit collection in an optimal way, as much information as possible should be written down. An example of an information sheet is given in Table 5.

The following information is needed:

- date of collection
- location, either street, field number, preferably locations taken with GPS
- fruit species, variety
- number of fruits and weight
- results, i.e. number and species of flies, pupae, parasitoids, etc.

Routine analysis of the information should be conducted and periodic reports submitted to higher management within the programme. Information most be kept updated at all times and available for consultation.

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Table 5. Example of fruit collection records in year 2003

2003									
sample number	longitude	latitude	date	fruit species	location	district	number	weight	date of check + results
							of fruits	in grams	
F 12526	-55.10595087	5.86223698	6/1/03	carambola	Paramaribo		2	372	3/2=no infestation
F 12527	-55.62862715	5.841094919	8/1/03	rose apple	Saramacca	Damboentong	11	193	3/2=no infestation
F 12528	-55.58593081	5.83407332	8/1/03	carambola	Saramacca	Damboentong	5	400	3/2=1 pupa
F 12531	-55.48453937	5.79828613	8/1/03	carambola	Saramacca	Groningen	5	355	3/2=48 Bactrocera+13 pupae
F 12560	-55.08172272	5.18207252	17/1/03	Eugenia prob. Florida	Brokopondo	Klaaskreek	8	55	3/2=2 Anastrepha
F 12595	-55.1469525	5.7449643	29/1/03	carambola	Para	Highway	6	250	12/2=143 Bactrocera+1 Anastrepha+4 pupae
F 12596	-55.11198068	5.70446292	30/1/03	carambola	Wanica	Highway	5	197	12/2=322 Bactrocera+10 pupae
F 12597	-55.16388863	5.7718052	30/1/03	carambola	Wanica	Dijkveld	5	274	12/2=47 Bactrocera+14 pupae
F 12598	-55.10202985	5.70135973	30/1/03	carambola	Para		5	227	12/2=64 Bactrocera+4 pupae
F 12608	-55.50315199	5.42135882	4/2/03	mispel (small)	Para	Poika	13	24	17/2=no infestation
F 12609	-55.50492762	5.41689022	4/2/03	hogplum	Para	Poika	17	255	25/2=30 Anastrepha+24 parasites+16 pupae
F 12610	-55.51018242	5.41329199	4/2/03	hogplum	Para	Poika	14	224	17/2=no infestation
F 12611	-55.34452584	5.24771448	4/2/03	hogplum	Para	Kwakoegron	15	120	28/2=10 Anastrepha+18 parasites+1 pupa
F 12612	-55.32295884	5.45170492	4/2/03	carambola	Para	Matta	3	125	17/2=no infestation
F 12613	-55.58000835	5.83709509	4/2/03	rose apple	Saramacca	Catharina Sophia	6	183	25/2=14 Bactrocera+4 pupae
F 12614	-55.54230608	5.82701649	4/2/03	rose apple	Saramacca	Catharina Sophia	10	352	17/2=no infestation
F 12615	-55.51820432	5.80285045	4/2/03	rose apple	Saramacca	Damboentong	6	125	17/2=no infestation
F 12616	-55.48952377	5.79379352	4/2/03	rose apple	Saramacca	Groningen	10	205	28/2=no infestation
F 12617	-55.58679609	5.82778764	4/2/03	carambola	Saramacca	Damboentong	8	525	17/2=no infestation
F 12618	-55.48382902	5.80563027	4/2/03	West-Indian cherry	Saramacca	Groningen	15	125	17/2=no infestation
F 12619	-55.58818318	5.82804555	4/2/03	carambola	Saramacca	Catharina Sophia	5	660	17/2=no infestation
F 12620	-55.54881544	5.82246134	4/2/03	Syzygium sp.	Saramacca	Catharina Sophia	6	65	17/2=no infestation

ANNEX 3

GUIDELINES ON C ORRECTIVE ACTION PLANS

The detection of a single specimen (adult or immature) of the target fruit fly species in the FF-PFA triggers enforcement of a corrective action plan.

The objective of the corrective action plan is to determine the phytosanitary status of the detection (actionable or non actionable) and, in case of an outbreak, to ensure eradication of the pest to enable reinstatement of the FF-PFA.

The corrective action plan should be prepared taking into account the biology of the target fruit fly species, the geography of the FF-PFA area, climatic conditions and host distribution within the area.

The elements required for implementation of a corrective action plan include:
- legal framework under which the corrective action plan can be applied
- criteria for the declaration of an incursion or outbreak
- time scales for the initial response
- technical criteria for delimiting trapping, fruit sampling, application of the eradication actions and establishment of regulatory measures
- availability of sufficient operational resources
- identification capability
- effective communication within the NPPO and with the trading partner, including provision of contact details of all parties involved.

Actions to apply the corrective action plan

1. Determination of the phytosanitary status of the detection (actionable or non actionable)
Immediately after the detection, a delimiting survey, which includes additional traps, and usually fruit sampling as well as an increased trap inspection rate, should be implemented to assess if the detection is an incursion or an outbreak. This action is also used to determine the size of the affected area.

2. Suspension of FF-PFA status
If the detection is a transient non actionable occurrence (ISPM No. 8: *Determination of pests status in an area*), no further action is required. If the detection is an outbreak, the FF-PFA status in the affected area should be terminated. The affected area may be limited to parts of the FF-PFA or may be the whole of the FF-PFA.

3. Implementation of control measures in the affected area
Specific eradication actions should be immediately implemented in the affected area(s). Eradication actions may include:
- selective insecticide-bait treatments
- sterile fly release if required
- male annihilation technique
- destruction of affected fruit.

Phytosanitary measures should be immediately enforced, including cancellation of shipments of fruit commodities from the affected area and operation of road stations to prevent the movement of infested fruit from the affected area to a pest free area. Other measures could be adopted if agreed by the importing country, for example treatment, increased surveys, supplementary trapping.

4. Criteria for reinstatement of a FF-PFA after an outbreak and actions to be taken
The criteria for determining that eradication has been successful should be based on having no further detections for at least three life cycles of the target pest species. The time period will depend on the biology of the species and the prevailing environmental conditions. Once the criteria have been fulfilled the following actions should be taken:
- Notification of appropriate agencies
- Reinstatement of normal surveillance levels
- Reinstatement of the FF-PFA.

5. Notification of relevant agencies

Relevant NPPOs, other agencies and trading partners should be kept informed at all times as appropriate.

APPENDIX 1

MOST IMPORTANT FRUIT FLY PESTS

Scientific name	English common name	Major hosts [1]
Anastrepha fraterculus[2] (Wiedemann)	South American fruit fly	Apple (*Malus pumila*), avocado (*Persea americana*), carambola (*Averrhoa carambola*), citrus (*Citrus* spp.), coffee (*Coffea arabica*), guava (*Psidium guajava*), mango (*Mangifera indica*), Myrtaceae, peach (*Prunus persica*), pear (*Pyrus communis*)
A. grandis (Macquart)	South American cucurbit fly	Cucurbits (including melon (*Cucumis melo*), pumpkin (*Cucurbita pepo*))
A. ludens (Loew)	Mexican fruit fly	Citrus (*Citrus* spp.), mango (*Mangifera indica*), peach (*Prunus persica*), pear (*Pyrus communis*)
A. obliqua (Macquart)	West Indian fruit fly	Mango (*Mangifera indica*), hog plum (*Ximenia americana*), red mombin (*Spondias purpurea*), carambola (*Averrhoa carambola*)
A. striata Schiner	Guava fruit fly	Guava (*Psidium guajava*), *Psidium* spp.
A. suspensa (Loew)	Caribbean fruit fly	Apple (*Malus pumila*), avocado (*Persea americana*), bell pepper (*Capsicum annuum*), guava (*Psidium guajava*), mango (*Mangifera indica*), orange (*Citrus sinensis*), papaya (*Carica papaya*)
Bactrocera carambolae Drew & Hancock *B. caryeae* (Kapoor)	Carambola fruit fly	Carambola (*Averrhoa carambola*), *Syzygium* spp., guava (*Psidium guajava*), mango (*Mangifera indica*) Citrus (*Citrus* spp.), guava (*Psidium guajava*), mango (*Mangifera indica*)
B. correcta (Bezzi)	Guava fruit fly (Asian)	Jujube (*Ziziphus jujuba*), guava (*Psidium guajava*), mango (*Mangifera indica*), peach tropical almond
B. cucumis (French)	Cucumber fruit fly	Cucurbits (including cucumber (*Cucumis sativus*), pumpkin (*Cucurbita pepo*), squash, zucchini), papaya (*Carica papaya*), tomato (*Lycopersicon esculentum*)
B. cucurbitae (Coquillett)	Melon fly	cucurbits (including cucumber (*Cucumis sativus*), pumpkin (*Cucurbita pepo*), squash watermelon)
B. dorsalis [3] (Hendel)	Oriental fruit fly	Apple (*Malus pumila*), banana (*Musa paradisiaca*), guava (*Psidium guajava*), mango (*Mangifera indica*), papaya (*Carica papaya*), peach (*Prunus persica*), pear (*Pyrus communis*)
B. kandiensis Drew & Hancock	Unkown	Mango (*Mangifera indica*)
B. latifrons (Hendel)	Solanum (Malaysian) fruit fly	Bell pepper (*Capsicum annuum*), chilli (*Capsicum* spp.), eggplant (*Solanum melongena*), tomato (*Lycopersicon esculentum*)
B. minax (Enderlein)	Chinese citrus fruit fly	Citrus (including grapefruit (*Citrus paradise*), kumquat (*Fortunella* sp.), lemon (*Citrus limon*) and orange (*Citrus sinensis*))
B. musae (Tryon)	Banana fruit fly	Banana (*Musa paradisiaca*), guava (*Psidium guajava*), papaya (*Carica papaya*)
B. neohumeralis (Hardy)	Lesser Queensland fruit fly	Apple (*Malus pumila*), citrus (*Citrus* spp.), coffee (*Coffea arabica*), guava (*Psidium guajava*), mango (*Mangifera indica*), peach (*Prunus persica*), plum (*Prunus domestica*)
B. occipitalis (Bezzi)	Unkown	Guava (*Psidium guajava*), mango (*Mangifera indica*)
B. oleae (Rossi)	Olive fruit fly	Olive (*Olea europaea*)
B. papayae[4] Drew & Hancock	Asian papaya fruit fly	Banana (*Musa paradisiaca*), carambola (*Averrhoa carambola*), coffee (*Coffea arabica*), guava (*Psidium guajava*), mango (*Mangifera indica*), papaya (*Carica papaya*)

B. philippinensis Drew & Hancock	Philippines fruit fly	Breadfruit (*Artocarpus altilis*), Malay apple (*Syzygium malaccense*), mango (*Mangifera indica*), papaya (*Carica papaya*)
B. pyrifoliae Drew & Hancock		Guava (*Psidium guajava*), peach (*Prunus persica*), sand pear (*Pyrus communis*)
B. tau[5] (Walker)		Cucurbits (including angled luffa (*Luffa acutangula*), cucumber (*Cucumis sativus*), pumpkin (*Cucurbita pepo*)), Malay apple (*Syzygium malaccense*)
B. tryoni (Froggatt)	Queensland fruit fly	Apple (*Malus pumila*), citrus (*Citrus* spp.), guava (*Psidium guajava*), Japanese persimmon (*Diospyros kaki*), mango (*Mangifera indica*), olive (*Olea europaea*), papaya (*Carica papaya*), peach (*Prunus persica*)
B. tsuneonis (Miyake)	Japanese orange fruit fly	Citrus (including kumquat (*Fortunella* sp.), orange (*Citrus sinensis*), tangerine (*Citrus deliciosa*)) and Fortunella spp.
B. umbrosa (Fabricius)	Artocarpus (Breadfruit) fruit fly	Artocarpus spp (including breadfruit (*Artocarpus altilis*), chempedak (*Artocarpus kemando*), jackfruit (*Artocarpus heterophyllus*))
B. xanthodes (Broun)	Pacific fruit fly	Breadfuit (*Artocarpus altilis*), granadilla (*Passiflora ligularis*), jackfruit (*Artocarpus heterophyllus*), papaya (*Carica papaya*)
B. zonata (Saunders)	Peach fruit fly	Date palm (*Phoenix dactylifera*), guava (*Psidium guajava*), mango (*Mangifera indica*), orange (*Citrus sinensis*), papaya (*Carica papaya*), peach (*Prunus persica*)
Ceratitis capitata (Wiedemann)	Medfly, Mediterranean fruit fly	Apple (*Malus pumila*), apricot (*Prunus armeniaca*), citrus (*Citrus* sp.), coffee (*Coffea arabica*), guava (*Psidium guajava*), mango (*Mangifera indica*), peach (*Prunus persica*), pear (*Pyrus communis*), persimmon (*Diospyros kaki*), tropical almond (*Terminalia catappa*)
Ceratitis rosa Karsch	Natal fruit fly	Apple (*Malus pumila*), avocado (*Persea Americana*), citrus (*Citrus* sp.), guava (*Psidium guajava*), lychee (*Litchi chinensis*), mango (*Mangifera indica*), papaya (*Carica papaya*), peach (*Prunus persica*)
Dacus ciliatus Loew	Ethiopian fruit fly	Cucurbits (including cucumber (*Cucumis sativus*), pumpkin (*Cucurbita pepo*), squash, watermelon (*Citrullus lanatus*))
D. frontalis Becker		Cucurbits (including cucumber, (*Cucumis sativus*), pumpkin (*Cucurbita pepo*), squash, watermelon (*Citrullus lanatus*))
Rhagoletis cerasi Loew	European cherry fruit fly	Cherries (*Prunus avium*) (including black, mahaleb (*Prunus mahaleb*), sour and sweet)
R. completa Cresson	Walnut husk fly	Walnuts (*Juglans regia*) (including black, Californian and Hinds' walnut), peach (*Prunus persica*)
R. indifferens Curran	Western cherry fruit fly	Choke cherry (*Prunus virginiana*), Japanese plum (*Prunus triflora*), Klamath plum (*Prunus subcordata*), sweet cherry (*Prunus avium*)
Rhagoletis pomonella (Walsh)	Apple maggot	Apple (*Malus pumila*), peach (*Prunus persica*), pear (*Pyrus communis*)
Toxotrypana curvicauda Gerstaecker	Papaya fruit fly	Papaya (*Carica papaya*)

[1] Major hosts only, see Bibliography for further information.
[2] *Anastrepha fraterculus* is a complex of undescribed species
[3] *B. dorsalis* occurs as a species complex in the Asian Pacific and includes*: B. carambolae, B. caryeae, B. dorsalis, B. kandiensis, B. occipitalis, B. papayae, B. philippinensis, B. pyrifoliae.*
[4] *B. papayae* is not a distinct species from *B. dorsalis* (Naeole, C.K.M. & Haymer, D.S. (2003) Use of oligonucleotide arrays for molecular taxonomic studies of closely related species in the

oriental fruit fly (*Bactrocera dorsalis*) complex. Molecular Ecology Notes 3, 662-665;Tan, K. H. (2003) *Bactrocera dorsalis* complex and its problem in control. Pp 103 – 112. *In* Recent Trends on Sterile Insect Technique and Area-Wide Integrated Pest Management - Economic Feasibility, Control Projects, Farmer Organization and *Bactrocera dorsalis* Complex Control Study - Research Institute for the Subtropics, Okinawa, Japan.)

[5] *B. tau* is a complex of undescribed species in Asia.

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